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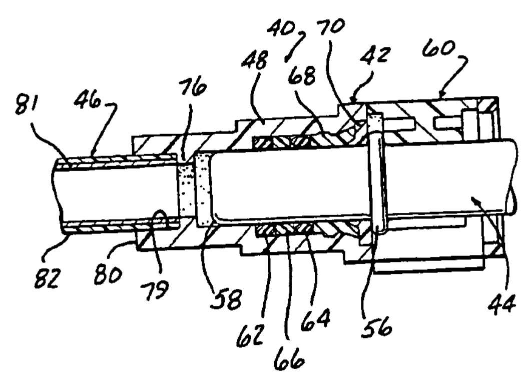
(54) Title: SPIN WELDED FLUID CONNECTOR USING PLASTIC COATED METAL TUBE



(57) Abstract: A joint between a fluid connector body and a metal tube carrying a plastic outer layer is formed by spin welding, wherein the portion of the connector body which is configured to receive the tube defines an end surface which engages the outer plastic surface of the mating tube to create a circumferentially continuous seal between the fluid passageway in the connector body and the outside environment. A radially inward extending flange in the connector body extends into the interior passage at a position spaced from an end opening in the connector body which receives the metal tube. The flange acts as an insertion limiter for the metal tube.

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SPIN WELDED FLUID CONNECTOR USING PLASTIC COATED METAL TUBE

BACKGROUND

[0001] The present invention relates to fluid connectors and, more particularly, to the sealing interconnection of such connectors with tubing end forms and, more particularly still, the use of spin welding to effect such interconnection.

[0002] Quick connect couplings have been widely used in the U.S. Automobile industry for many years. Although applicable in numerous applications, quick connectors are typically employer in fuel system and vapor recovery systems. The simplest and most cost effective design is the plastic housing female type quick connector releasably mated to a metal male tube tube end. The opposite end of the female housing most typically defines a stem having a member of axially spaced barbs formed on the outer circumferential surface thereof and a nylon or plastic tubing tube end pressed there over. Such an arrangement is described in U.S. Patent 5,542,712, issued August 6, 1996, entitled "Quick Connector Housing With Elongated Barb Design".

[0003] In fluid handling systems, it is imperative that the connectors used have their male and female portions properly coupled together. A faulty connector enables an associated system to leak fluid. This can be particularly disadvantageous when the system is under pressure and the leaking connector expels the pressurized fluid. Furthermore, recent federal legislation has mandated significantly reduced hydrocarbon emissions from automotive fuel and vapor recovery systems. Conventional quick connectors, although effective to mechanically maintain tubing tube ends in assembly with their associated connector bodies, have not adequately addressed the federal requirements. Also, the materials employed, typically nylon 12, do not provide sufficient resistance to the permeation of hydrocarbons therethrough.

[0004] The permeation problem has been addressed in part through the development of co-extruded multi-layer plastic tube containing two or more discrete layers of different types or formulations of plastic, one of which is specifically designed to provide an effective permeation layer, blocking the escape of hydrocarbons from the system. In general, the most successful multi- layer tubing employs a relatively thick outer layer composed of a material resistant to the exterior environment. The innermost layer is thinner and is composed of a material which is chosen for its ability to block defusion of materials, such as hydrocarbons, alcohols and other materials present in fuel blends, to the outer layer and may have a degree of electrical conductivity sufficient to dissipate static charges generated by the flow of fluid therein. To date, it has been extremely difficult to obtain satisfactory lamination characteristics between dissimilar polymer layers. Thus, the use of one or more intermediate layers for bonding the inner and outer layers has been proposed.

[0005] The use of multi-layer tubing in fuel related applications has been problematic inasmuch as the tubing end or tube end necessarily exposes the lamina ends of the inner and outer layers as well as any intermediate layers to either the system fuels and vapors or the equally harsh exterior environment. Such exposure tends to degrade the bonding between the various layers, causing delamination or separation of the layers, resulting in loss of system integrity, fuel contamination and even blockage of fluid flow.

[0006] A related problem stems from dual aspects of commercially available quick connect devices, to wit: high volume and low sale price frequently necessitating the use of inexpensive, somewhat pliable materials, and complex contours of extremely small inter-fitting components. These aspects collectively increase the likelihood of misassembly. High volume production techniques, including automated assembly tends to aggravate the problem wherein misassembly or impermissible dimensional variations of the components is difficult to detect. Excessive dimensional tolerance stack-up can result in low pull-apart characteristics between the barbed stem and the plastic tube and produce leakage. Misassembly, such as failure to include a 0-ring, can also result in leakage. In the case of

multi-layer tubes, dimensional and/or adhesive problems can result in mechanical delamination upon insertion of the tube over the barbed stem. Finally, mono-wall plastic tube or multi-layer structures with low hoop strength can relax over time or at elevated temperatures, resulting in leaking or weeping of fluid.

SUMMARY

[0007] The present invention provides a simple and inexpensive yet mechanically and environmentally robust connection between a tube tube end and a connector body as well as an assembly that overcomes the shortcomings of the prior art.

[0008] The present fluid connector is designed for spin welding connection with a plastic-coated, metal tube. The connector includes a body having a through passage which interconnects a first opening which is adapted for receiving a mating conduit and a second opening which is adapted for receiving the tube. The end portion of the through passage at second opening defines a surface which sealingly engages the outer surface of the tube. This arrangement has the advantage of reliably sealing the tube end with the connector body, preventing both fluid leakage and the incursion of environmental contaminants.

[0009] In one aspect, this invention is a fluid connector for spin welding connection with a metal tube having a plastic outer layer affixed thereon. The connector includes a body defining a through passage interconnecting a first opening adapted for receiving a mating conduit, and a second opening adapted for receiving the tube.

[0010] In another aspect, a fluid coupling includes a connector body defining a through passage interconnecting a first opening adapted for receiving a conduit and an opposed second opening. An inner surface is formed in the body disposed about the second opening; the inner surface defining an inner welding surface. A metal tube end has an outer plastic layer affixed thereto. The outer plastic layer is spin welded to the inner welding surface on the connector body.

[0011] Preferably, the second opening defines an annular inner surface at one end of the through passage. A flange is spaced from the second opening in the

through passage and extends radially inward from the connector body into the through passage. The flange is engagable by a leading end of the tube.

[0012] The spin welded fluid connector of the present invention provides a secure, completely sealed connection between a metal tube end and a plastic connector body by using a spin welding process wherein a plastic outer layer affixed on the metal tube is spin welded to an inner surface of the plastic connector body.

BRIEF DESCRIPTION OF THE DRAWING

[0013] The various features, advantages, and other uses of the present invention will become more apparent by referring to the following detailed description and drawing in which:

[0014] Figure 1 is a cross-sectional view of a spin welded fluid coupling of the present invention;

[0015] Figure 2 is a longitudinal, cross-sectional view of a connector body shown in Figure 1;

[0016] Figure 3 is an exploded, cross-sectional view on an enlarged scale, of the fluid coupling of Figure 1 prior to spin welding of the tube end into the connector body;

[0017] Figure 4 is a cross-sectional view on a greatly enlarged scale of the spin weld connection of the tube end to the connecter body; and

[0018] Figure 5 is a cross-sectional view on a greatly enlarged scale showing the spin weld connection of the tube end to a modified aspect of the connector body.

DETAILED DESCRIPTION

[0019] Referring to Figures 1 - 4, the preferred aspect of the present invention is illustrated in an application comprising a quick connector assembly or fluid coupling 40 in which a connector 42 serves to interconnect a metal tubing member end 44 and a plastic and metal tube end 46 to effect a fluidic circuit, preferably for automotive applications.

[0020] As best illustrated in Figure 2, the connector 42 is an assembly of a hard shell plastic connector body 48 formed of glass filled nylon or other suitable material in a generally tubular form having a stepped bore 50 extending therethrough from a first opening 52 to a second opening 54.

[0021] The metal tubing member end 44 extends through the first opening 52 into the bore 50 as shown in Figure 1. An upset bead 56, axially off set from a leading end 58 of the tube 44, releasable engages a retainer 60 which is in assembly with the body 48. The outer peripheral surface of the metal tube 44 is sealingly engaged with the body 48 within the bore 50 by first and second resilient O-rings 62 and 64 separated by a spacer 66 and held in the illustrated position by a second spacer 68 and a top hat 70. As illustrated, the leading end 58 of the metal tube end 44 can be inserted within the bore 50 and mechanically engage the connector 42 without the use of tools or specialized assembly equipment. The metal tube end 44 can be released from the connector 42 by resiliently displacing the retainer 60.

[0022] An intermediate step portion 72 of the bore 50 in the connector body 48 is dimensioned to ensure a slip fit with the leading end 58 of the metal tube 44 to establish intimate contact therewith.

[0023] A flange 77 is integrally formed with and extends axially leftwardly from the main portion of the connector body 48 in the orientation of Figure 2. The flange 76 terminates at a leading nose 80. The flange 76 is circular and concentric with the second opening 54 and defines an interior bore 79.

[0024] The plastic and metal tube end 46 is preferably formed of a metal tube or conduit having a metal sidewall 81 which is covered by a plastic material outer layer 82. The plastic outer layer 82 is securely affixed to the metal layer 81 by means of co-extrusion and other well-known techniques.

[0025] One particular plastic and metal tube end 46 which is ideally suited for use in the present invention is a nylon 12-carbon steel tube end manufactured and sold by the assignee of the present invention under the trade name "NYCLAD." It will be understood that other types of metal as well as other plastic materials may be employed to practice the present invention.

[0026] Although the plastic outer layer 82 of the tube end 46 has been illustrated as being a mono-wall layer, it will be understood that a multi-layer construction of different plastic layers affixedly joined to each other and to the metal tube end 81 or at least two plastic layers with an intermediate conductive material layer may also be employed for the tube end 46. The innermost corner of the leading edge 80 of the connector body 48 may also be beveled or angled to provide a lead-in feature to enhance the insertion of the tube end 46 into the endmost bore 79 on the connector body 48.

[0027] Referring to Figures 3 and 4, the spin welding process of mounting the plastic and metal tube end 46 on the connector body 48 is illustrated. As shown in Figure 4, tube end 46 is pre-positioned concentrically with the second opening 54 and spaced slightly axially therefrom. The nominal outer diameter of the tube end 46 is slightly greater than the inner diameter of the leading nose 80 to ensure that as the tube end 46 contacts the connector body 48, a leading edge 96 thereof will first contact the leading nose 80 to preposition and self-center the two. The self-centering feature also eliminates the need for guide mandrels during spin welding.

[0028] An interior flange 76 is formed in the connector body 48 between the bores 72 and 79. The flange 76 has an annular form with a central aperture 78. The aperture 78 is in fluid flow communication with the stepped bore 50 and the second opening 54. The flange 76 acts as an insertion limit for the plastic and metal tube end 46 into the through passage extending inward from the second opening 54. Preferably, the radial extent of the flange 76 from the adjoining sidewall of the connector body 48 has a dimension substantially equal to the total wall thickness of the plastic and metal tube end 46.

[0029] As the tube end 46 is axially pressed into engagement with the connector body 48, the tube end 46 is mounted rigidly and the connector body 48 is mounted for relative rotation therewith in a suitable press, for example. Once a suitable speed differential is established, the tube end 46 and the connector body 48 are axially pressed together as illustrated by the arrow 98 until the leading edge 96 of

the tube end 46 contacts the flange 76 at which time all relative axial displacement and rotational displacement ceases.

[0030] During the spin welding process, the outer surface 100 of the outer layer 82 of the tube end 46 frictionally engages the inner surface of the bore portion 79 to melt the surfaces thereof to establish an outer weldment zone 104 best seen in Figure 4.

[0031] The various control perimeters in spin welding are generally well known, albeit in other applications. For the sake of brevity they will not be repeated here, reference being made to U.S. Patents 2,933,428 to Mueller, 3,980,248, to Minoshima and 5,152,855 to Jansman et al.

[0032] It is desirable to employ materials in the plastic layer 82 and the connector body 48 that are compatible, particularly in melting temperature which will mix predictably as they solidify from the molten state established during the spin welding process. This produces a weldment with optimized structural integrity.

[0033] Figure 5 depicts a modification of the quick connector body 48 according to another aspect of the present invention. In this aspect, the end bore portion 79' extending inward from the second opening 54, instead of having a constant diameter, smooth wall configuration, as shown in Figure 2, is formed with a first converging tapered portion 84 extending from the flange 76 which transitions into a more abrupt, steeper angled, second tapered portion 86 terminating in the second opening 54 at the leading nose 80.

[0034] During the spin welding process, the steeper angle of the second tapered portion 86 creates greater friction at the leading end 96 of the tube end 46 resulting in higher amounts of heat and faster melting of the end portion of the plastic outer layer 82 of the tube end 46 and the end of the connector body 48.

[0035] As the tube end 46 and the connector body 48 are continued to be axially advanced into each other, the plastic outer layer 82 of the tube end 46 will pass along the less steep, first tapered portion, 84. Both of the first and second tapered portions 84 and 86 on the connector body 48 provide weld zones which

insure a complete, 360°, annular seal between the plastic outer layer 82 of the tube end 46 and the connector body 48.

[0036] Further details concerning the construction and use of the double-tapered portion on the connector body 48 as well as the additional flash traps may be had by referring to U.S. Patent No. 6,199,916, entitled "Spin Welded Fluid Connector", which is assigned to the same assignee as the present invention.

[0037] In conclusion, there has been disclosed a unique fluid connector which uses spin welding to ensure a sealed connection between a plastic coated metal tube and a plastic quick connector body, the other end of which body is sealingly coupled to another tube end. The unique quick connector and fluid coupling according to the present invention enable a metal tube to be sealingly joined to a plastic connector body via a fast spin welding process which ensures a complete 360° seal between the tube and the connector body.

What is Claimed is:

1. In combination, a fluid connector for spin welding connection with a metal tube having a plastic outer layer affixed thereon, the connector comprising:

a body defining a through passage interconnecting a first opening adapted for receiving a mating conduit, and a second opening adapted for receiving the metal tube.

2. The combination of claim 1 wherein the second opening defines an annular inner surface at one end of the through passage.

3. The combination of claim 1 further comprising:

a flange spaced from the second opening in the through passage and extending radially inward into the through passage, the flange engagable by a leading end of the metal tube.

4. The combination of claim 1 further comprises:

a retainer mounted in the connector body to releasably engage an abutment surface on the mating conduit.

5. A fluid coupling comprising:

a connector body defining a through passage interconnecting a first opening adapted for receiving a conduit and an opposed second opening defining an inner surface formed in the body, the inner surface defining an inner welding surface; and

a metal tube having a plastic outer layer affixed thereto, the outer plastic layer spin welded to the inner welding surface on the connector body.

6. The fluid coupling of claim 5 wherein the second opening defines an annular inner surface at one end of the through passage.

7. The fluid coupling of claim 5 further comprising:

a flange spaced from the second opening in the through passage and extending radially inward into the through passage, the flange engagable by a leading end of the metal tube.

8. The fluid coupling of claim 5 further comprises:

a retainer mounted in the connector body to releasably engage an abutment surface on the conduit.

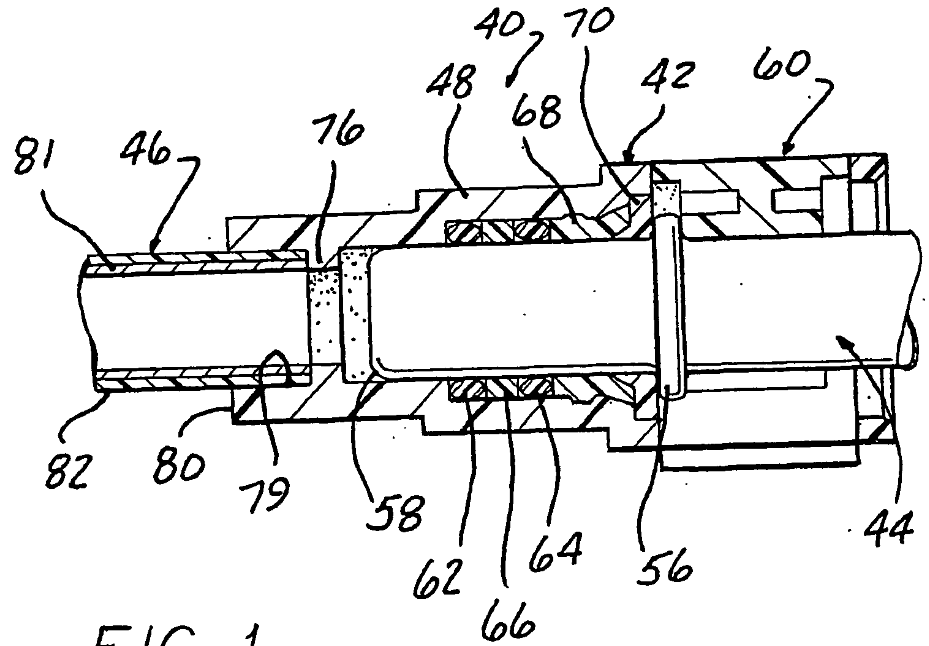
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FIG. 1

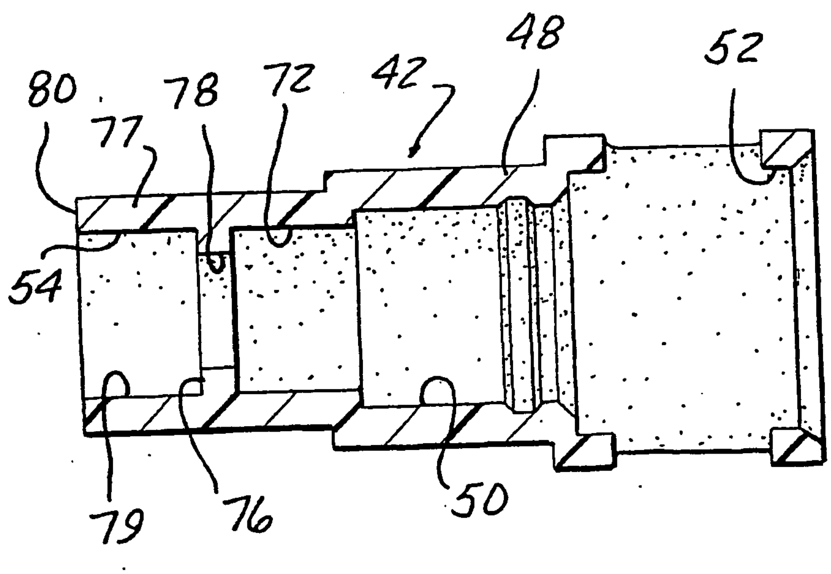
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FIG. 2

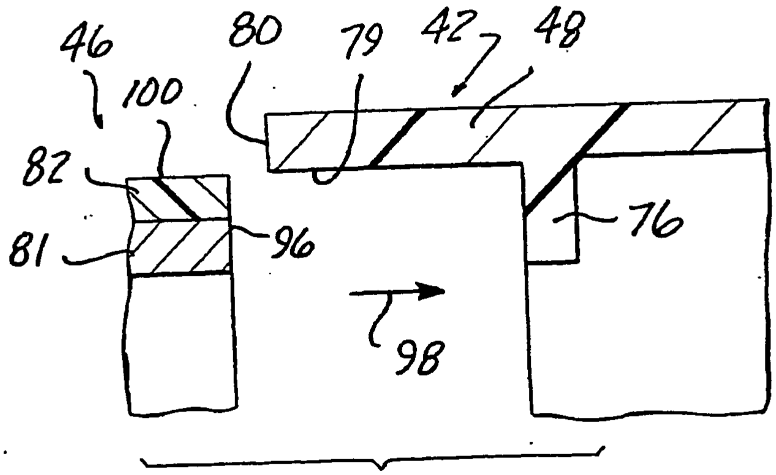

FIG. 3

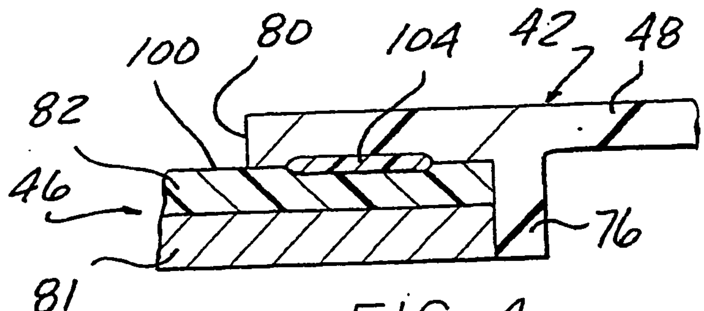

FIG. 4

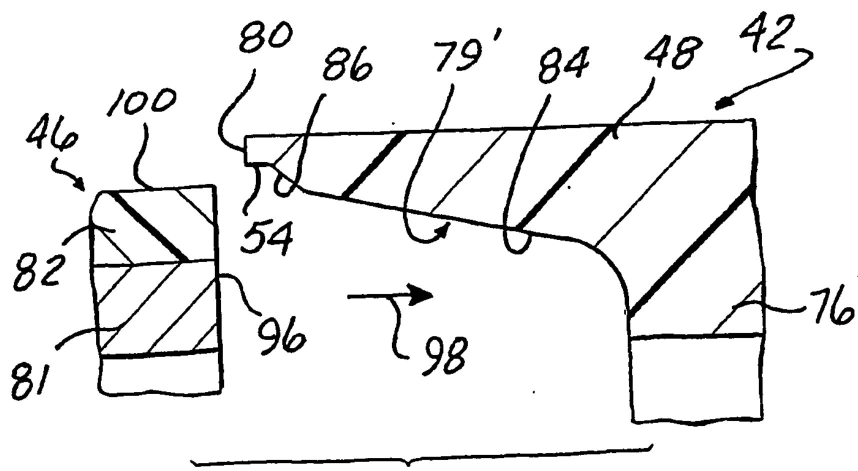

FIG. 5